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ABSTRACT

Interest scales designed to provide educational and vocational guidance to midshipmen at the U.S. Naval Academy were developed from the Strong Vocational Interest Blank. Three of the scales provided an index of similarity between a person's interests and the interests of previous graduates from each of the Academy's three academic areas: Engineering-Weapons, Mathematics-Science, and Humanities-Social Science. A fourth scale, the Applied-Science scale, was designed to distinguish the Engineering-Weapons majors from the Mathematics-Science students. These scales would also be used to satisfy the Navy's requirements for particular numbers of commissioned officers trained in each of the three broad areas. The four scales were cross-validated, and the validity of each scale was found to be significant. Four alternative strategies for utilizing the scales were discussed. When these strategies were compared with the probable scale results that would occur by chance, all four strategies were found to significantly improve upon the chance results. (Author/GDC)

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VOCATIONAL INTERESTS AND THEIR RELATIONSHIP TO ACADEMIC MAJOR AREAS AT THE U.S. NAVAL ACADEMY

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The research objective was the development and evaluation of interest scales designed to provide an index of similarity between a midshipman's interests (as measured by the Strong Vocational Interest Blank) and the interests of Naval Academy graduates in each of three broad academic areas. The validity for each scale was significant in each cross-validation sample. Four alternative strategies for using the interest scales were evaluated and compared.

FOREWORD

This research and development was performed in support of Advanced Development Subproject ZPN01.06, Advanced Navy Recruiting System.

The study focused on the development and evaluation of interest scales to aid midshipmen in vocational-educational guidance. More specifically, empirical scales on the Strong Vocational Interest Blank were developed to determine the degree of similarity between a midshipman's measured interests and those of graduates in each of the three academic majors: (1) Engineering-Weapons, (2) Mathematics-Science, and (3) Humanities-Social Sciences. This information would be useful in the selection of an academic major.

The assistance of the Naval Academy throughout all phases of this research is gratefully acknowledged. The considerable efforts of LCDR Robert D. McCullah, formerly with the Department of Behavioral Science, were responsible for expediting this investigation and helped ensure its successful completion. The interest, cooperation, and support of RADM Robert W. McNitt, USN (Ret.), Dean of Admissions; Dr. John F. Kelley, Jr., Assistant Dean for Academic Affairs; and Dr. Gregory Mann, Chairman, Behavioral Science Department, are especially appreciated.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

Effective procurement, development, and retention of officer personnel continue to be important objectives for the Navy. The U.S. Naval Academy, one important source of commissioned officers, offers education organized under three broad academic areas: (1) Group I—Engineering-Weapons, (2) Group II—Mathematics-Science, and (3) Group III—Humanities-Social Science. Although midshipmen are given choices among these program areas, Academy policy requires that certain proportions of each class select majors in each area. The general problem addressed in the present research is to provide midshipmen with information that will help them to choose academic majors that are personally satisfying while, at the same time, ensuring that Academy goals are achieved.

Objective

This study developed and evaluated interest scales designed to provide an index of similarity between a person's measured interests and those of graduates in each of the three broad academic areas.

Approach

Strong Vocational Interest Blank (SVIB) responses and ultimate choice of major field were available for the Classes of 1971, 1972, 1973, and 1975. Four separate interest scales were developed on the Class of 1973: (1) the Engineering-Weapons (E-W) Scale, designed to separate Group I majors from others (II & III), (2) the Mathematics-Science (M-S) Scale, designed to separate Group II majors from others (I & III), (3) the Humanities-Social Science (H-S) Scale, designed to separate Group III majors from all others (I & II), and (4) the Applied-Science (A-S) Scale, designed to separate Group I majors from Group II majors.

The four individual scales were cross-validated separately for the Classes of 1971, 1972, and 1975. Four alternative strategies for utilizing the scales were compared with chance results and with each other in terms of classification accuracy.

Cross-validation of the individual scales produced the following ranges of biserial correlations: (1) the E-W Scale - from .42 to .50, (2) the M-S Scale - from .16 to .37, (3) the H-S Scale - from .66 to .73, and (4) the A-S Scale - from .27 to .32. All biserial validities for each scale in each sample were highly significant ($p < .01$).

The effectiveness of four alternative strategies for utilizing the information provided by the interest scales was examined. The "hit rate" (percent correct classifications) was employed as the basis for evaluating the strategies. All four strategies were found to significantly improve upon chance result ($p < .01$).

Conclusions

Consideration of institutional goals in conjunction with classification accuracy lead to the conclusion that, of the four strategies for using the interest scales, the best was an optimal personnel assignment algorithm with current quotas for the three academic areas. The assignments generated by the algorithm would provide recommendations on choice of major area.

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INTRODUCTION

Problem

The United States Naval Academy is an important source of commissioned officers that offers numerous alternative career opportunities. Until 1959, the curriculum was uniform and consisted of a "lock-step" sequence of courses. There was no program involving different majors or minors, and no elective courses were available. In 1959, advanced placement based upon test results was introduced for the new plebe class (Class of 1963), and an electives program was initiated. All midshipmen still had Naval Science as an academic major; however, when they had completed the plebe year, those who were most academically qualified were offered the opportunity of participating in the electives program; that is, they could choose a minor in one of twelve subject areas.

The "Majors Program," instituted in 1969, provided majors organized under four broad academic areas: (1) Engineering, (2) Science, (3) U.S. and International Studies/English and History, and (4) Management. However, beginning with 1973 (Class of 1977), curricula for these areas were structured into three groups: (1) Group I--Engineering-Weapons, (2) Group II--Mathematics-Science, and (3) Group III--Humanities-Social Science. The curricula for the management majors were substantially altered and grouped administratively under Group II. For convenience, in the remainder of this report, the term "original" will designate the organization of majors that existed prior to and for the Class of 1976; and the term "current," to the organization that began with the Class of 1977.

As indicated in The Majors Program (1974), published by the Academy as Academic Dean Notice 1531, there is a marked emphasis on the technical majors of Groups I and II:

> The Naval Academy policy on the selection of majors is clear. Each midshipman selects a major which will meet the needs of the Navy and at the same time be interesting to him. The needs of the Navy take first priority and it has been determined that 80 percent of the Class shall take a technical major, i.e., Group I or II, and 20 percent may choose Group III. Hopefully, the selection of majors by the Class of 1978 will meet the 80/20 quota. If the desired distribution is not obtained by an open, free selection process, steps will be taken to adjust the distribution to meet the Navy goals. (p. 9)

The Academy was directed to increase the proportion of engineering and science majors from 65 percent to the 80 percent referred to above by the Bureau of Naval Personnel. This increase is necessary if the Navy is to meet present and future requirements for high quality naval officers with engineering and science backgrounds. If the characteristics of incoming midshipmen remain the same (which is likely to be the case), there is little reason to expect that 15 percent more of them will select engineering or science majors. This decision point is reached in the Spring of the plebe

year, which is earlier than in civilian colleges, where a choice of major is most often made at the conclusion of the sophomore year. As a result, early vocational-educational guidance based at least in part on interests may play an especially important role in the Naval Academy setting.

Background

A substantial amount of research on interests and their relationship to various criteria of performance and satisfaction has been accomplished in the past 10 to 15 years. The Strong Vocational Interest Blank (SVIB) has been found to be one of the most useful psychometric instruments for measuring these interests (Campbell, 1966).

Abrahams and Neumann (1973) studied the relationship between SVIB responses and performance at the U.S. Naval Academy. Specifically, these investigators developed scales for predicting three criteria: motivational disenrollment, academic disenrollment, and military aptitude. All of these new scales were found to be significantly related to their respective criteria in cross-validation samples.

In another study, Neumann and Abrahams (1974) developed an SVIB scale designed to identify Naval Academy applicants with engineering and science interests. The Class of 1973 was split into key-development and cross-validation samples. The criterion employed was dichotomous: Engineering-Science majors versus "Other" majors. A biserial validity of .57 was obtained for this Engineering-Science (E-S) Scale in the cross-validation sample. Further, application of the E-S scale to the class of 1976 yielded a biserial validity of .62. The results of this investigation were also reported in a paper presented at an Air Force symposium (Abrahams & Neumann, 1974).

The E-S Scale was developed as an aid in selecting students with engineering or science interests from the pool of Academy applicants. The operational selection composite involves a number of different predictors. Thus, the relationship between the E-S Scale and the current predictors was examined and the validity of alternative composites was evaluated against various criteria (e.g., cumulative grade point average, major choice, etc.) (Neumann & Abrahams, 1976). As a result of this research, both the Disenrollment Scale and the Engineering-Science Scale will be employed in computing the candidate multiple for selecting applicants for the Class of 1980.

Purpose

The global purpose of this research is the development of tools that will aid the Naval Academy staff in the educational-vocational guidance of the students. The specific objective of this effort is to construct interest scales that will provide an index of the degree of similarity between an individual's interests, as measured by the Strong Vocational Interest Blank, and those of persons who have successfully graduated in each of the three current broad academic areas at the Academy. This information on individual interests can be used, in conjunction with institutional requirements, to guide midshipmen in the selection of an academic major.

PROCEDURE

Instrument

The 1966 edition of the Strong Vocational Interest Blank (SVIB) for men is a paper-and-pencil inventory consisting of 399 items relating to activities in 23 basic interest areas. These areas include occupational specialties, school subjects, amusements and hobbies, and general activities. The respondent is asked to indicate his degree of interest in the activity described in the particular item by responding with "Like," "Indifferent," or "Dislike."

In 1966, 1967, and 1968, this version of the SVIB was administered to all midshipmen (selectees for the Classes of 1971, 1972, and 1973) on an experimental basis at the inception of their respective plebe summers. In 1969, it was administered on a voluntary basis as part of the application procedure. However, beginning in 1970, for selection of the class of 1975, it became a required part of the application packet.

Sample

Since complete SVIB data were available for the Classes of 1971 through 1973 and 1975, these classes were selected for construction and evaluation of the new SVIB scales. As indicated above, the SVIB was administered to all selectees for the Classes of 1971 through 1976. Those persons who failed to graduate were removed from these three samples. Further, since the management science major area was eliminated in 1973, for the Class of 1977, those persons graduating with a management major also were removed from the 1971, 1972, and 1973 samples. For the Class of 1975, the SVIB was administered to all applicants. However, the sample included only the graduates.

The number and percentage of persons in each class majoring in each of the three current broad academic areas are shown in Table 1. As shown, two sets of data are provided for the Class of 1975. In the first set, which portrays the "original" organization of majors, which existed prior to and for the Class of 1976, General Engineering majors (N = 50) are included in Group I and Management-Science majors (N = 77) have been excluded. In the second set, which groups midshipmen to reflect the "current" organization, which began with the Class of 1977, General Engineering and Management majors are included in Group II. The first data set will provide a realistic picture of the effectiveness of the new SVIB scales if they were to be implemented under the original organization of academic majors; and the second data set, the current organization.

Criteria

The criterion for each scale developed was membership versus nonmembership in the respective major group. Four separate problems were addressed: (1) differentiation of Group I from Groups II and III; (2) differentiation of Group II from Groups I and III; (3) differentiation of Group III from Groups I and II; and (4) differentiation of Group I from Group II.

Table 1

Distribution of Persons by Academic Major Area for Naval Academy Classes

Academic Major Area	Naval Academy Classes									
	1971[a]		1972[a]		1973[a]		1975[b]		1975[c]	
	N	%	N	%	N	%	N	%	N	%
Engineering-Weapons (Group I)	225	34	169	26	171	26	280	40	230	30
Mathematics-Science (Group II)	264	40	307	48	314	47	255	37	382	49
Humanities-Social Sciences (Group III)	171	26	170	26	178	27	164	23	164	21
Total Sample	660	100	646	100	663	100	699	100	776	100

[a]Total less than the actual graduating class due to the exclusion of management majors.

[b]These data reflect the original organization of individual academic majors into broad areas.

[c]These data reflect the current organization of individual academic majors into broad areas.

Construction of Scales

The 1973 sample was used to construct the following four scales designed to address the four differentiation problems stated above: (1) the Engineering-Weapons (E-W) Scale, (2) the Mathematics-Science (M-S) Scale, (3) the Humanities-Social Science (H-S) Scale, and (4) the Applied Science (A-S) Scale.

An "empirical criterion keying" approach was used to select those SVIB items having the 75 best responses for each of the four problems addressed. Previous research has indicated that this number of responses produces effective SVIB scales. The proportions of high and low criterion group[1] members who endorsed each of the response alternatives for each of the items were computed, and the difference between these two endorsement rates was determined. The items containing the 75 responses exhibiting the greatest differences between endorsement rates of the high and low criterion groups were selected for subsequent analysis.

Twenty alternative item response weighting procedures were examined (Sands, 1975). These procedures ranged in complexity from a simple unit-weighting method to more involved methods, such as using Bayes' Theorem to obtain a response weight reflecting the posterior probability of being a high criterion group member, given that the response alternative was endorsed. The general conclusion reached was that the more esoteric methods of differential weighting offered no practical advantage over the simple-unit weighting procedure.

The response weighting method adopted for the four scales described in this report was a dimensionalized version of unit weighting, as recommended by Campbell (1971). This procedure considers each individual item as a continuum ranging from "Like" at one end to "Dislike" at the other. If one end of the continuum received a unit weight based upon the absolute difference in endorsement rates between the high and low criterion groups, a unit weight affixed with the opposite sign is given to the other end. If "Indifferent" is the only response alternative that exhibited the necessary difference between the endorsement rates of the high and low criterion groups, the item obviously does not have the assumed underlying continuum and, therefore, was eliminated from the scale. Campbell (1971) reports that dimensionalizing does not affect the validity of a scale but does provide slight improvement in test-retest reliability.

Development of Prediction Equations

Four separate linear regression equations were constructed on the 1972 sample, one for each of the four differentiation problems addressed. By coding group membership vs. nonmembership in a binary fashion, the simple regression equations estimated the probability of high criterion group membership as a linear function of the raw score on the appropriate scale.

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[1]The term "high criterion group" is used throughout the paper to indicate the group for whom the scale is being developed; and "low criterion group," to indicate nonmembership in that group.

Evaluation

Individual Scales

The effectiveness of the four individual scales was evaluated in a number of ways. The biserial validities and percent overlap indexes (Tilton, 1937) were computed separately for each scale in each sample. Also, an expectancy table which shows the proportion of high criterion group members scoring in each quintile of the appropriate raw score predictor distribution, was constructed for each scale in each sample.

Classification Strategies

Four alternative classification strategies were evaluated. The first strategy examined the separate probability estimates of membership in the three academic areas. An individual was classified into the group for which his score indicated the highest probability. Previous research (Sands & McCullah, 1974) demonstrated that separating Group I members from Group II members was more difficult than isolating Group III persons from Groups I and II. The second classification strategy was designed with this finding in mind. Initially, the probability of Group III membership was estimated using a person's raw score on the H-S scale. If this probability was greater than, or equal to, 0.5, he was classified as a Group III member; otherwise, he was considered as either a Group I or Group II member. Using his raw score on the A-S Scale (designed to differentiate between Groups I and II), his probability of Group I membership was estimated. If this estimate was greater than, or equal to 0.5, he was classified as a Group I member; otherwise, he was predicted to be a Group II member. It should be noted that neither of the first two strategies considers institutional goals for allocation to the three academic groups.

The third and fourth strategies employed a personnel assignment algorithm,[2] which optimally assigned each person to one of three major areas while meeting quotas for each area. The payoff matrix for both strategies employed the three probabilities of group membership estimates as the payoffs of assigning the individual to each of the three major groups. The third strategy used quotas set equal to the number of persons who actually majored in each academic area; and the fourth, quotas of 40 percent, 40 percent, and 20 percent for Groups I, II, and III respectively. As previously indicated, the Academy has published a goal of 80 percent for technical majors (Engineering-Weapons and Mathematics-Science majors) and 20 percent for nontechnical majors (Humanities-Social Science majors). The desired allocation between Engineering-Weapons (Group I) majors and Mathematics-Science (Group II) majors has not been specified. To estimate these separate quotas, the Class of 1978 was examined. The observed distribution of majors for Groups I, II, and III was 41, 39, and 20 percent respectively. Therefore, for the purpose of illustration, the quotas for the first two major groups were assumed to be equal.

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[2]The algorithm employed was the Ford-Fulkerson routine (1956) for solving the Hitchcock-Koopmans transportation problem. The computer program used was developed by Wolfe (1964).

The results for each strategy were evaluated separately for each sample. A three-by-three matrix with actual group membership on one dimension and predicted (or "assigned") group membership on the other dimension portrayed the obtained results. The frequencies on the diagonal were correct classifications and the proportion of correct classifications, or "hit rate," was used as an index of strategy effectiveness.

The obtained results for each strategy in each sample were compared with chance level results. Finally, the four alternative strategies were compared.

RESULTS

Evaluation of Individual Scales

Engineering-Weapons (E-W) Scale.

Table 2 presents statistical results for the E-W Scale for each Academy class. As shown, cross-validation of this scale yielded biserial correlations ranging from .42 to .50, all of which are highly significant ($p < .01$).

The percent overlap is another index that is useful in describing the extent to which a predictor can separate two groups (e.g., Engineering-Weapons majors from all others). This index is based upon the difference in means of the two groups divided by the average of the two standard deviations (Tilton, 1937). It can vary from zero, representing perfect separation of the score distributions of the two groups, to 100, representing a complete overlap. Hence, a low percent overlap indicates a highly effective predictor variable. As shown in Table 2 the cross-validated percent overlap coefficients for the E-W Scale range from 65 to 70. The magnitude of these index indicates relatively good separation of criterion groups.

The practical significance of applying the E-W Scale can be illustrated using expectancy charts, as shown in Figure 1. The raw score categories for all expectancy charts were formed by combining the raw score distributions for the classes of 1971 and 1972. This total distribution was divided into quintiles, each fifth as nearly equal in sample size as possible. Then, treating each class separately, the percentage of Engineering-Weapons majors was computed for each quintile. As indicated in Figure 1a, those persons in the Class of 1971 scoring in the top quintile of the E-W Scale selected Engineering-Weapons majors almost six times more frequently than those persons scoring in the lowest quintile. Of the persons scoring in the top 60 percent of the E-W score distribution, 46 percent were Engineering-Weapons majors, as compared with a base rate[3] of 34 percent.

Figures 1b, 1c, and 1d portray the effectiveness of the E-W Scale as applied to the remaining three cross-validation problems. The results are similar to those obtained for the Class of 1971.

Mathematics-Science (M-S) Scale

The results of statistical analyses on the M-S Scale are presented in Table 3. The cross-validated biserial validity coefficients range from .16 to .37, all of which are highly significant ($p < .01$). These validities correspond to overlap coefficients ranging from 89 to 76. These high overlap coefficients reflect the difficulty of differentiating between the Mathematics-Science majors and persons majoring in the other two broad academic areas.

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[3]The base rate is the proportion of high criterion group members in the total distribution. For example, in the Class of 1971, there were 225 Engineering-Weapons majors out of a total of 660, yielding a base rate of .34.

Table 2

Descriptive Statistics for the Engineering-Weapons (E-W) Scale
for the Naval Academy Classes

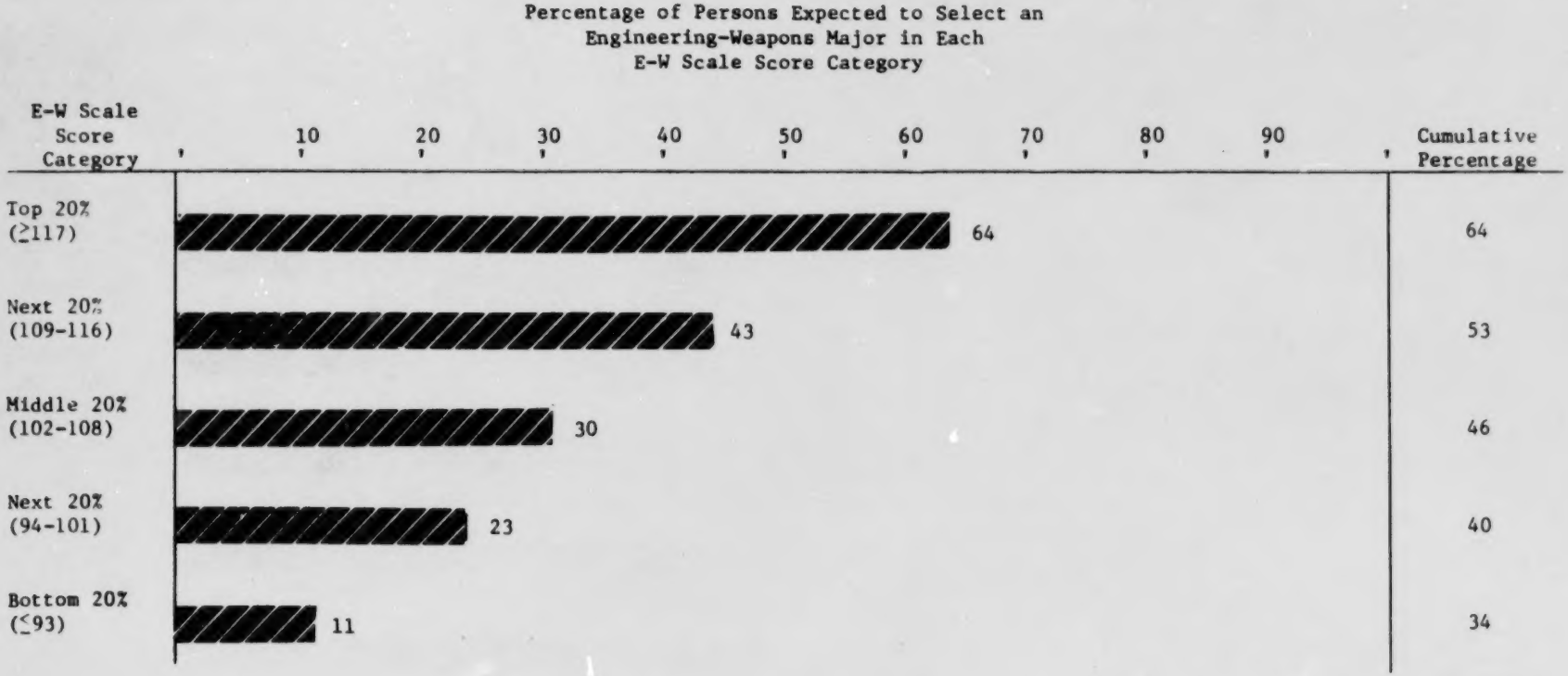
Class	Criterion Group	Major Group(s)	Sample Size	Mean	Standard Deviation	Biserial Validity	Percent Overlap
1971	High	I	225	111.969	11.698		
	Low	II & III	435	100.966	12.814	.50*	65
	Total		660	104.717	13.487		
1972	High	I	169	112.083	11.235		
	Low	II & III	477	102.428	13.762	.42*	70
	Total		646	104.954	13.809		
1973[a]	High	I	171	112.789	10.811		
	Low	II & III	492	99.746	13.898	.54*	60
	Total		663	103.110	14.349		
1975[b]	High	I	280	112.057	11.677		
	Low	II & III	419	101.394	13.125	.49*	67
	Total		699	105.665	13.601		
1975[c]	High	I	230	112.361	11.847		
	Low	II & III	546	102.361	13.093	.45*	69
	Total		776	105.325	13.524		

[a]The statistics for the Class of 1973 are biased, as the scale was constructed using these persons. Specifically, capitalization on chance inflates the validity and deflates the percent overlap.

[b]These results are based upon the original majors organization.

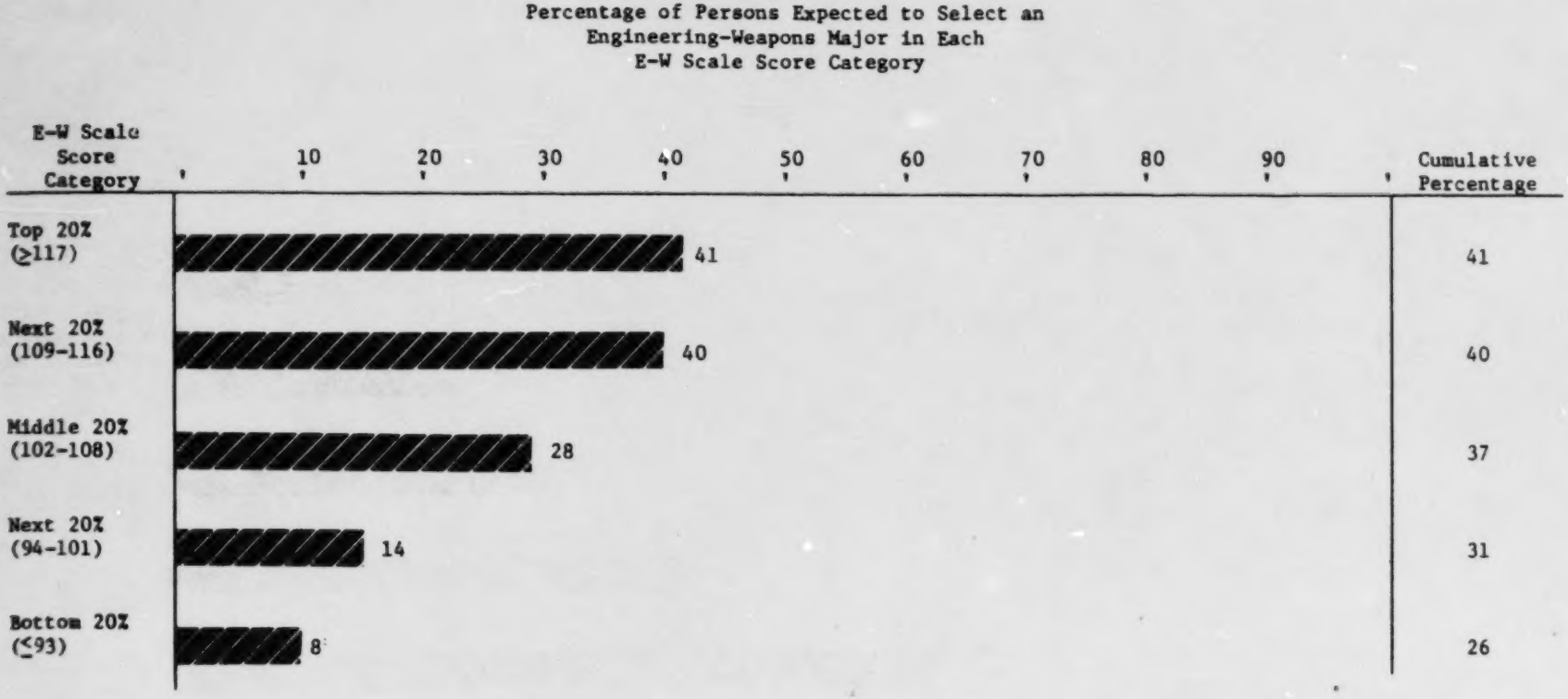
[c]These results are based upon the current majors organization.

*Statistically significant ($p < .01$), based upon Alf & Abrahams (1971).



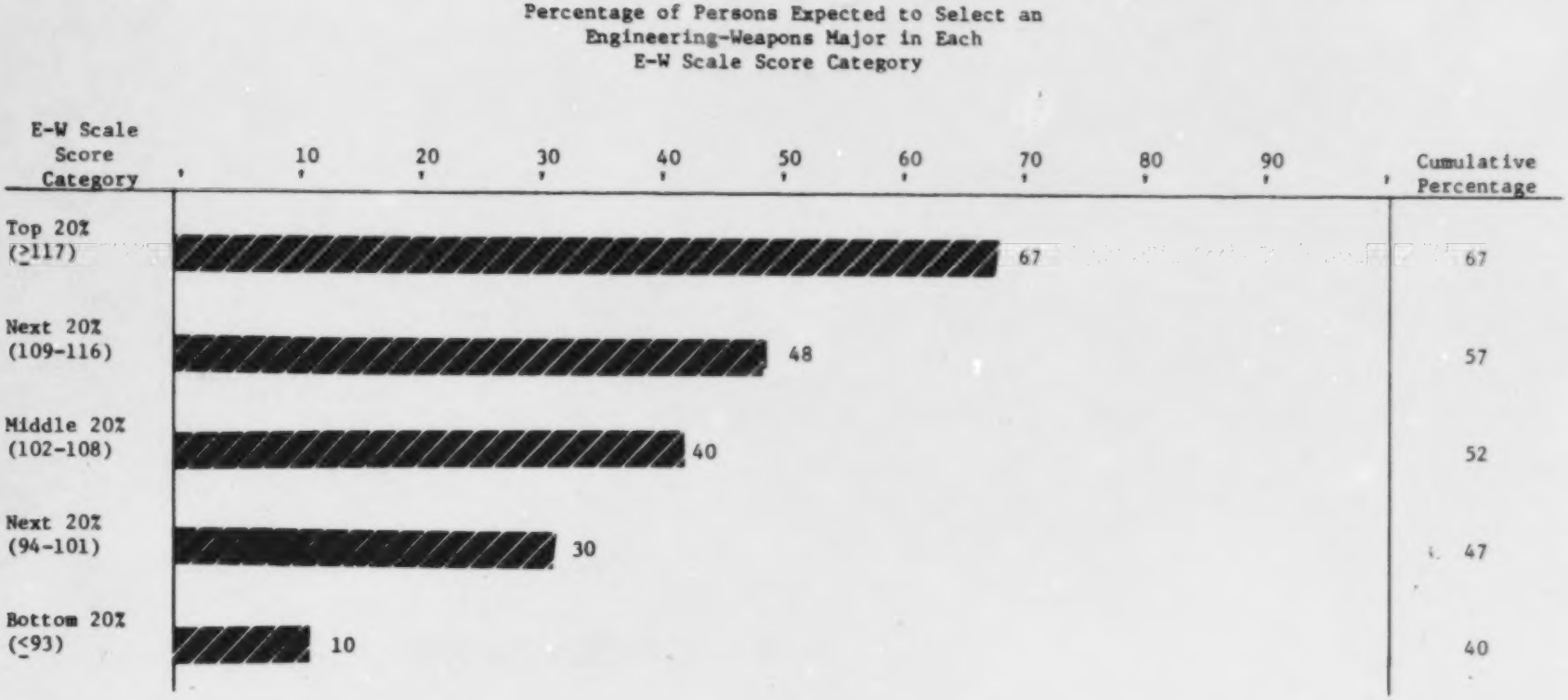
a. Class of 1971.

Figure 1. Expectancy charts showing the relationship between the E-W Scale and choice of major field for the Naval Academy classes.



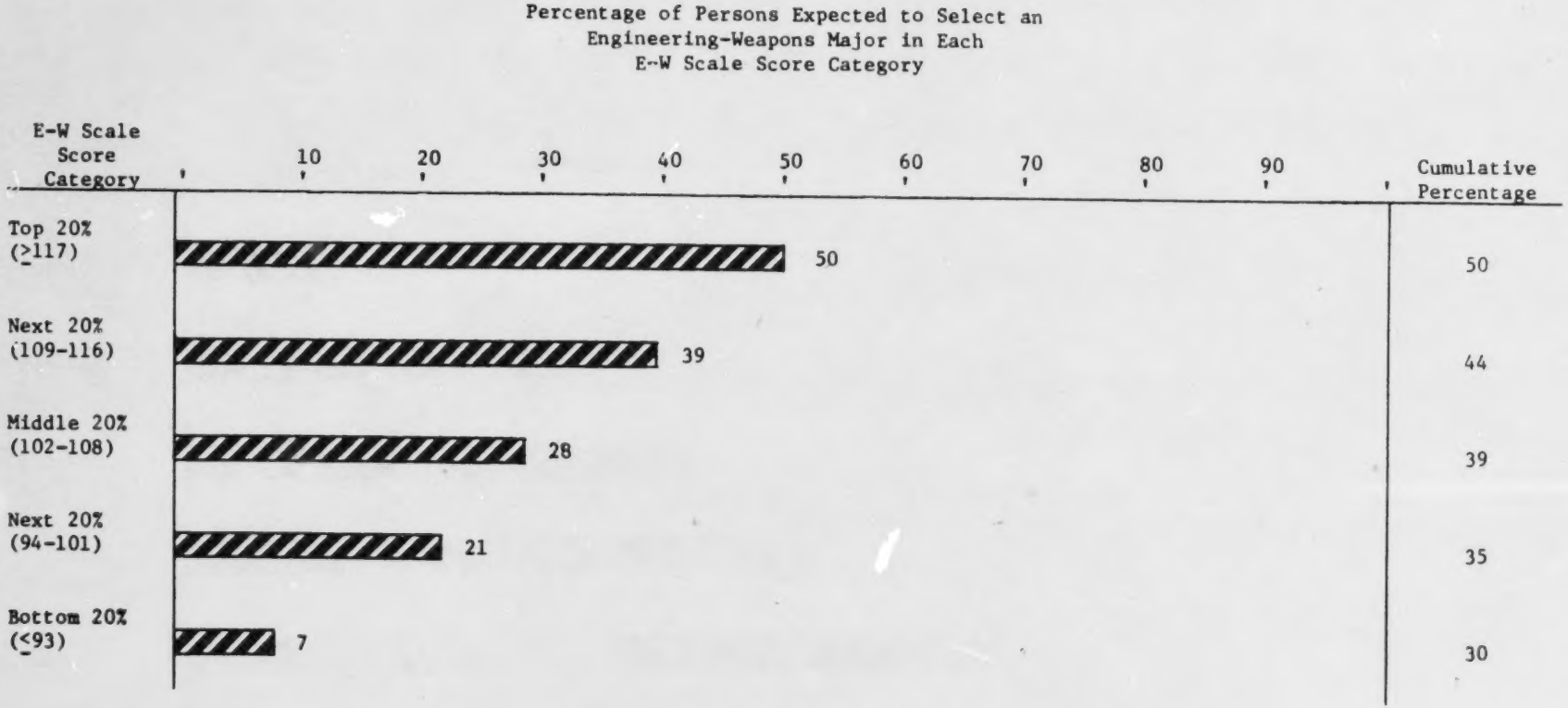
b. Class of 1972.

Figure 1. (Continued)



c. Class of 1975--Original major groups.

Figure 1. (Continued).



d. Class of 1975--Current major groups.

Figure 1. (Continued).

Table 3

Descriptive Statistics for the Mathematics-Science (M-S) Scale
for the Naval Academy Classes

Class	Criterion Group	Major Group(s)	Sample Size	Mean	Standard Deviation	Biserial Validity	Percent Overlap
1971	High	II	264	111.462	9.776		
	Low	I & III	396	107.303	12.189	.23*	85
	Total		660	108.967	11.461		
1972	High	II	307	112.645	10.366		
	Low	I & III	339	105.472	12.940	.37*	76
	Total		646	108.881	12.312		
1973[a]	High	II	314	113.057	10.221		
	Low	I & III	349	103.989	13.346	.44*	70
	Total		663	108.284	12.789		
1975[b]	High	II	255	112.435	9.897		
	Low	I & III	444	109.318	12.949	.16*	89
	Total		699	110.455	12.013		
1975[c]	High	II	382	111.872	10.198		
	Low	I & III	394	108.716	13.105	.17*	89
	Total		776	110.269	11.862		

[a]The statistics for the Class of 1973 are biased, as the scale was constructed using these persons. Specifically, capitalization on chance inflates the validity and deflates the percent overlap.

[b]These results are based upon the original majors organization.

[c]These results are based upon the current majors organization.

*Statistically significant ($p < .01$), based upon Alf & Abrahams (1971).

Figure 2 illustrates the lack of sharp differentiation between Mathematics-Science majors and others. For the Class of 1971, if only those persons scoring in the top quintile of the M-S Scale distribution are considered, only 47 percent were Mathematics-Science majors, which is not markedly higher than the 40 percent base rate.

Humanities-Social Science (H-S) Scale

Table 4 presents the results of a statistical evaluation of the H-S Scale. The biserial validity coefficients range from .66 to .73 in the cross-validation samples, all of which are highly significant ($p < .01$). The percent overlap coefficients corresponding to these validities range from 53 to 46.

Figure 3 illustrates the high effectiveness of the H-S Scale. Of all the persons in the Class of 1971 scoring in the top quintile of the H-S Scale score distribution, 67 percent were majoring in the Humanities-Social Science area, as contrasted with only 1 percent of those scoring in the bottom quintile. The base rate for the Class of 1971 was 26 percent.

Applied Science (A-S) Scale

Results of statistical analyses on the A-S Scale are shown in Table 5. Cross-validated biserial correlations ranged from .27 to .32 and, statistically, are highly significant ($p < .01$). The corresponding percent overlap coefficients ranged from 82 to 79.

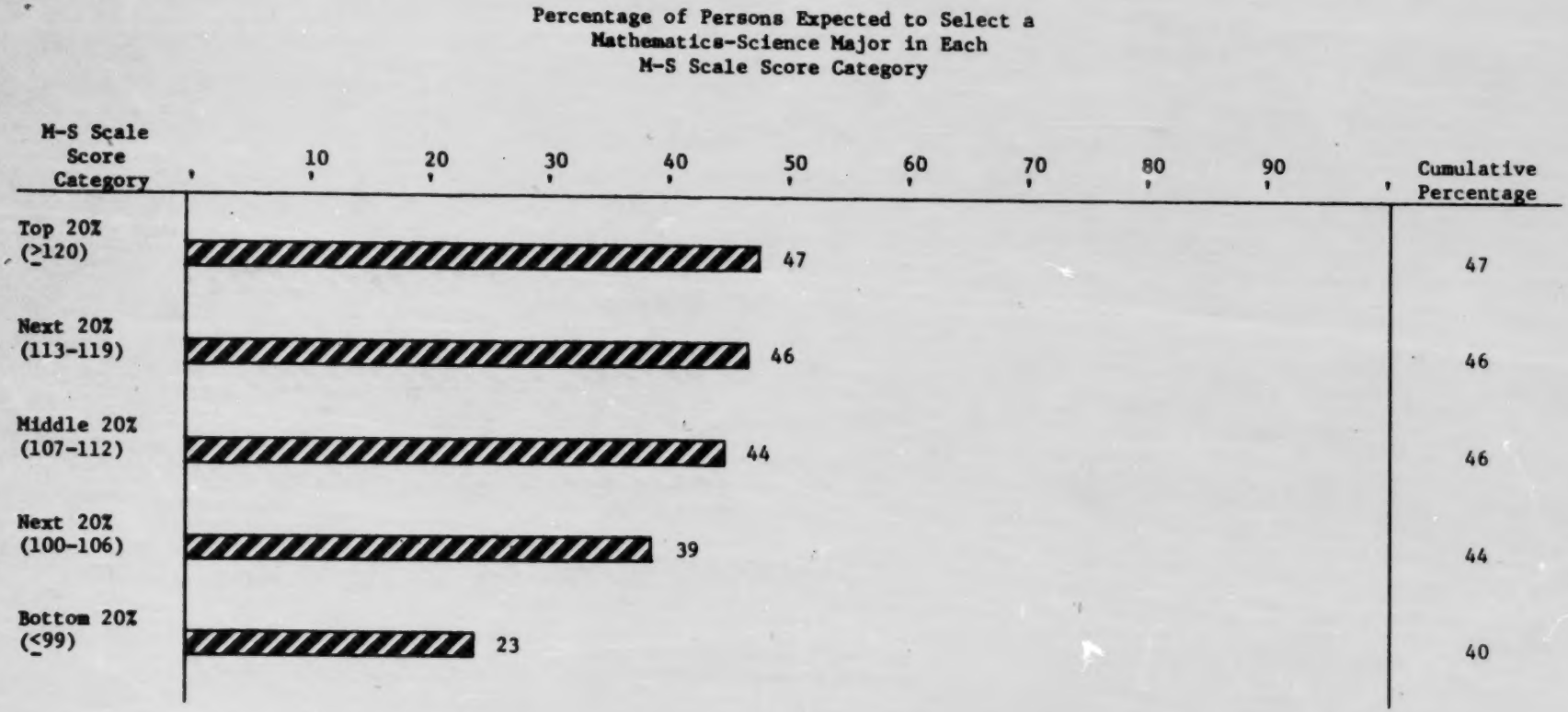
Figure 4 illustrates the effectiveness of the A-S Scale for the four cross-validation problems. In the Class of 1971, over twice as many Engineering-Weapons majors scored in the top quintile of the A-S Scale distribution as scored in the bottom quintile of the score distribution.

Evaluation of Classification Strategies

The results for the four alternative classification strategies were evaluated separately for each sample. A three-by-three matrix, with actual group membership on one dimension and predicted or assigned group membership on the other dimension, was constructed for each strategy, as applied to each sample.

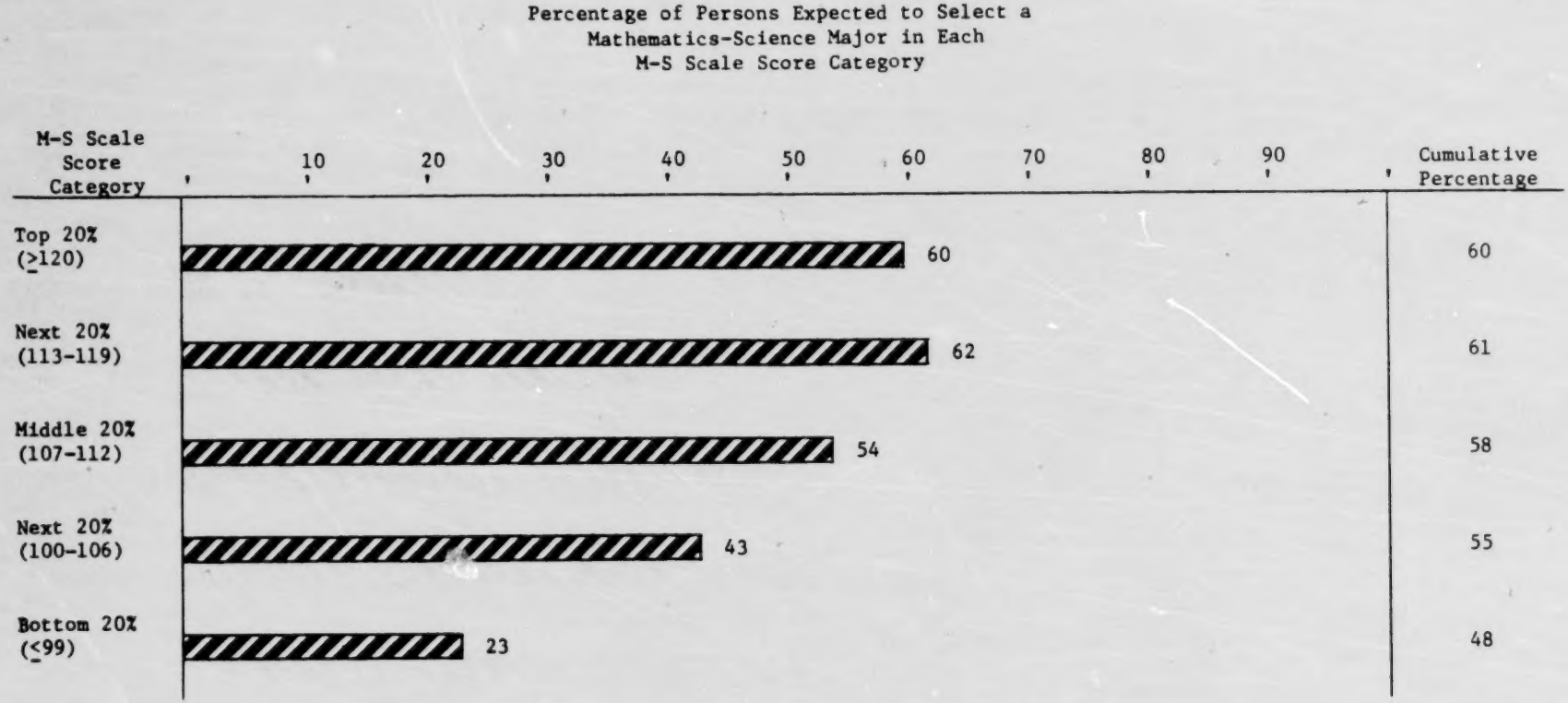
A corresponding matrix representing chance results was constructed for each strategy in each sample. These detailed results are presented in the Appendix. The hit rate obtained for each strategy was compared with the hit rate that would have been obtained by chance. The results for the four alternative strategies are presented in Table 6. The obtained results were significantly better ($p < .01$) than the corresponding chance results for every strategy examined for each separate sample.

As previously indicated, the first two strategies are based solely upon probability of group membership estimates and institutional requirements are ignored. In every sample, the classification accuracy of Strategy #2 equals or exceeds the accuracy of Strategy #1. This finding was expected, as the second strategy employs more information than is used by the first strategy.



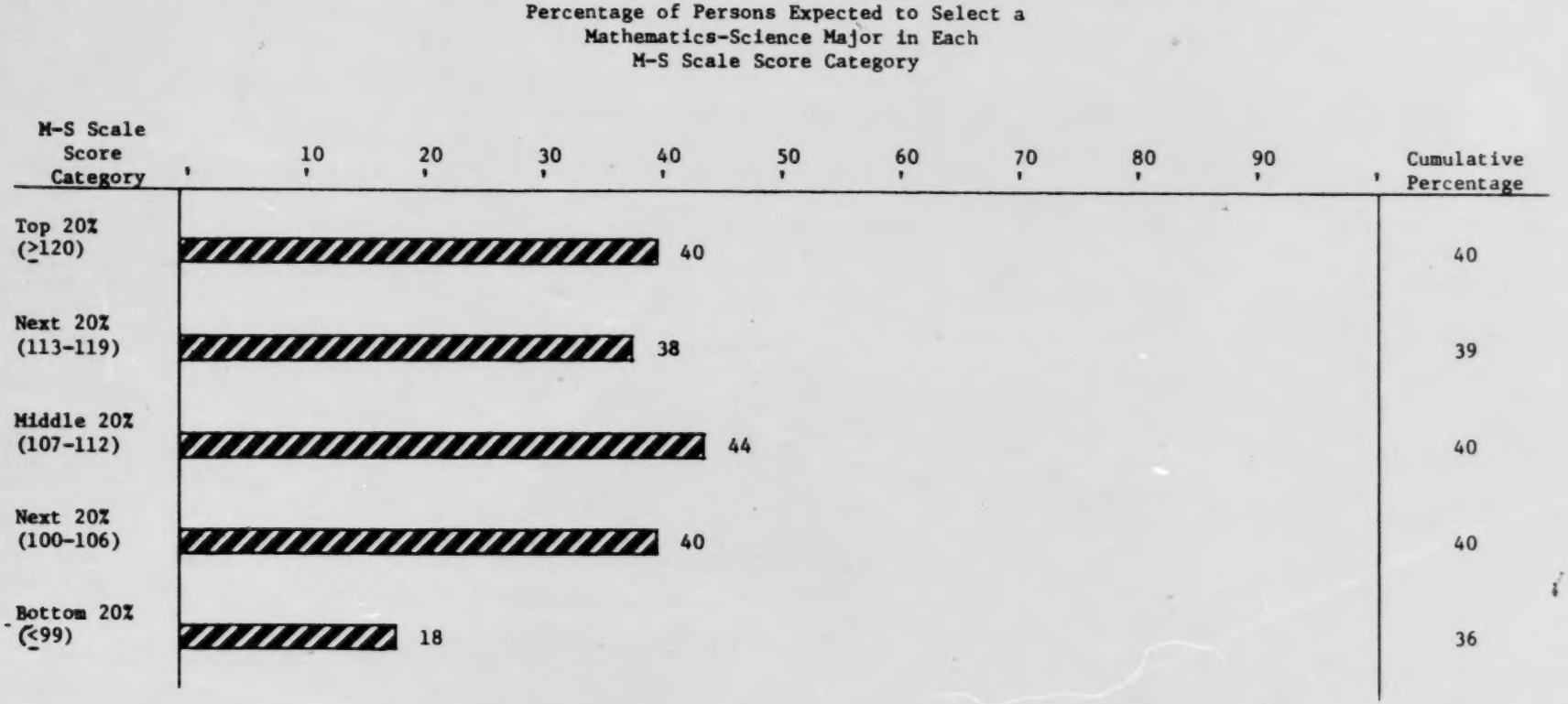
a. Class of 1971.

Figure 2. Expectancy charts showing the relationship between the M-S Scale and choice of major field for the Naval Academy classes.



b. Class of 1972.

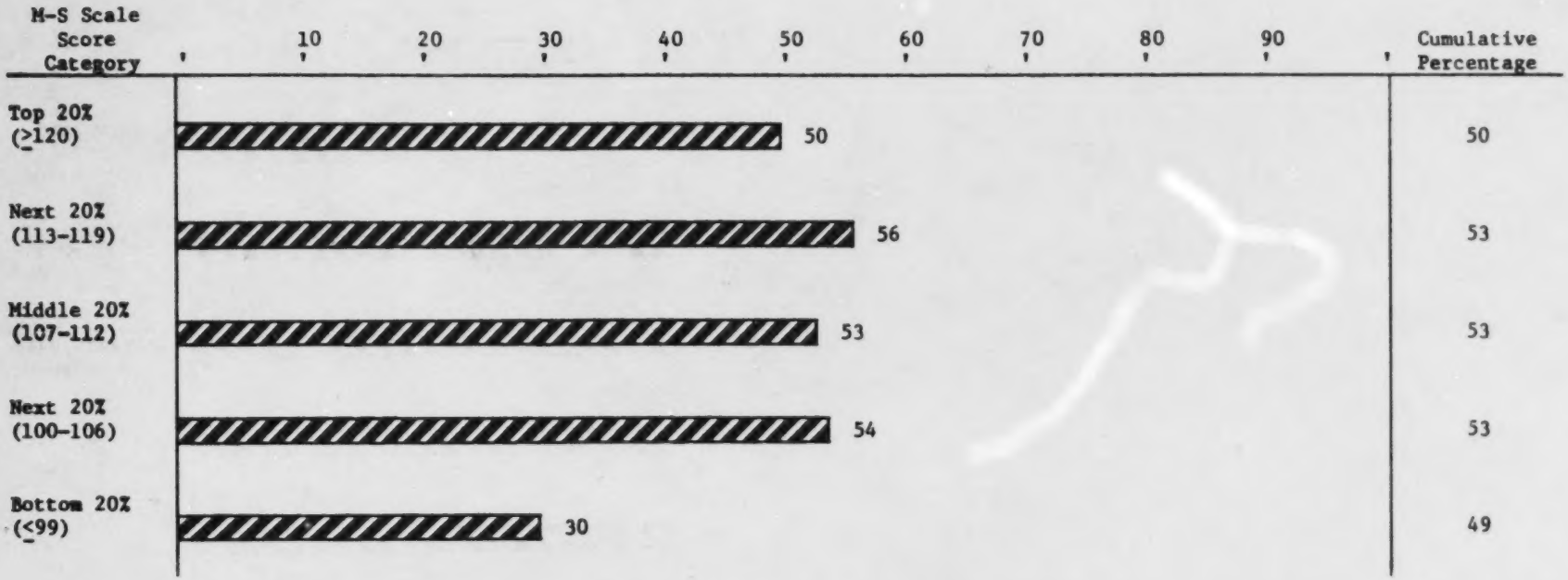
Figure 2. (Continued).



c. Class of 1975--Original major groups.

Figure 2. (Continued).

Percentage of Persons Expected to Select a
Mathematics-Science Major in Each
M-S Scale Score Category



d. Class of 1975--Current major groups.

Figure 2. (Continued).

Table 4

Descriptive Statistics for the Humanities-Social Science (H-S) Scale
for the Naval Academy Classes

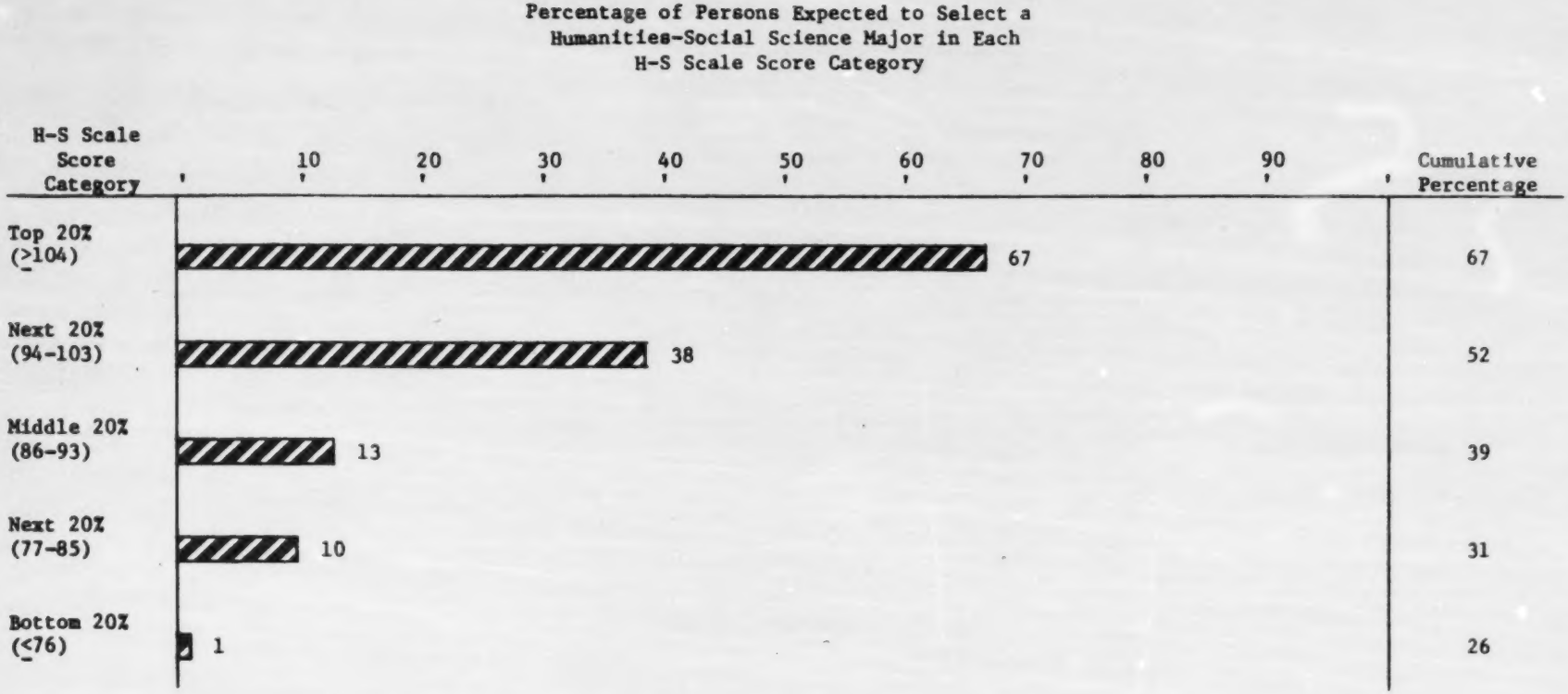
Class	Criterion Group	Major Group(s)	Sample Size	Mean	Standard Deviation	Biserial Validity	Percent Overlap
1971	High	III	171	104.684	14.486		
	Low	I & II	489	85.534	13.114	.72*	49
	Total		660	90.495	15.874		
1972	High	III	170	105.159	13.632		
	Low	I & II	476	85.042	13.691	.73*	46
	Total		646	90.336	16.289		
1973[a]	High	III	178	108.140	15.328		
	Low	I & II	485	86.394	13.041	.77*	44
	Total		663	92.232	16.738		
1975[b]	High	III	164	105.098	15.083		
	Low	I & II	535	85.593	13.499	.71*	49
	Total		699	90.169	16.154		
1975[c]	High	III	164	105.098	15.083		
	Low	I & II	612	86.042	13.957	.66*	53
	Total		776	90.543	16.071		

[a]The statistics for the Class of 1973 are biased, as the scale was constructed using these persons. Specifically, capitalization on chance inflates the validity and deflates the percent overlap.

[b]These results are based upon the original majors organization.

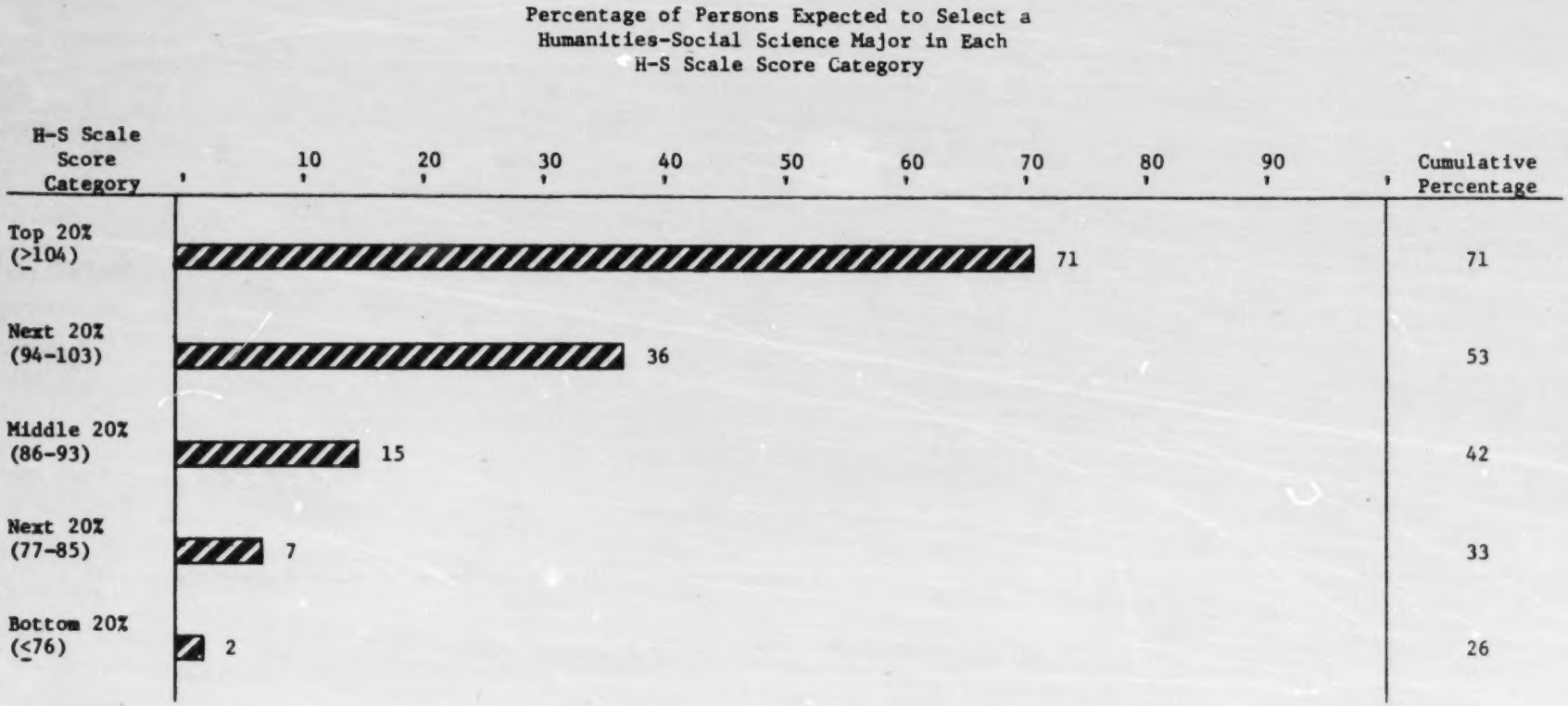
[c]These results are based upon the current majors organization.

*Statistically significant ($p < .01$), based upon Alf & Abrahams (1971).



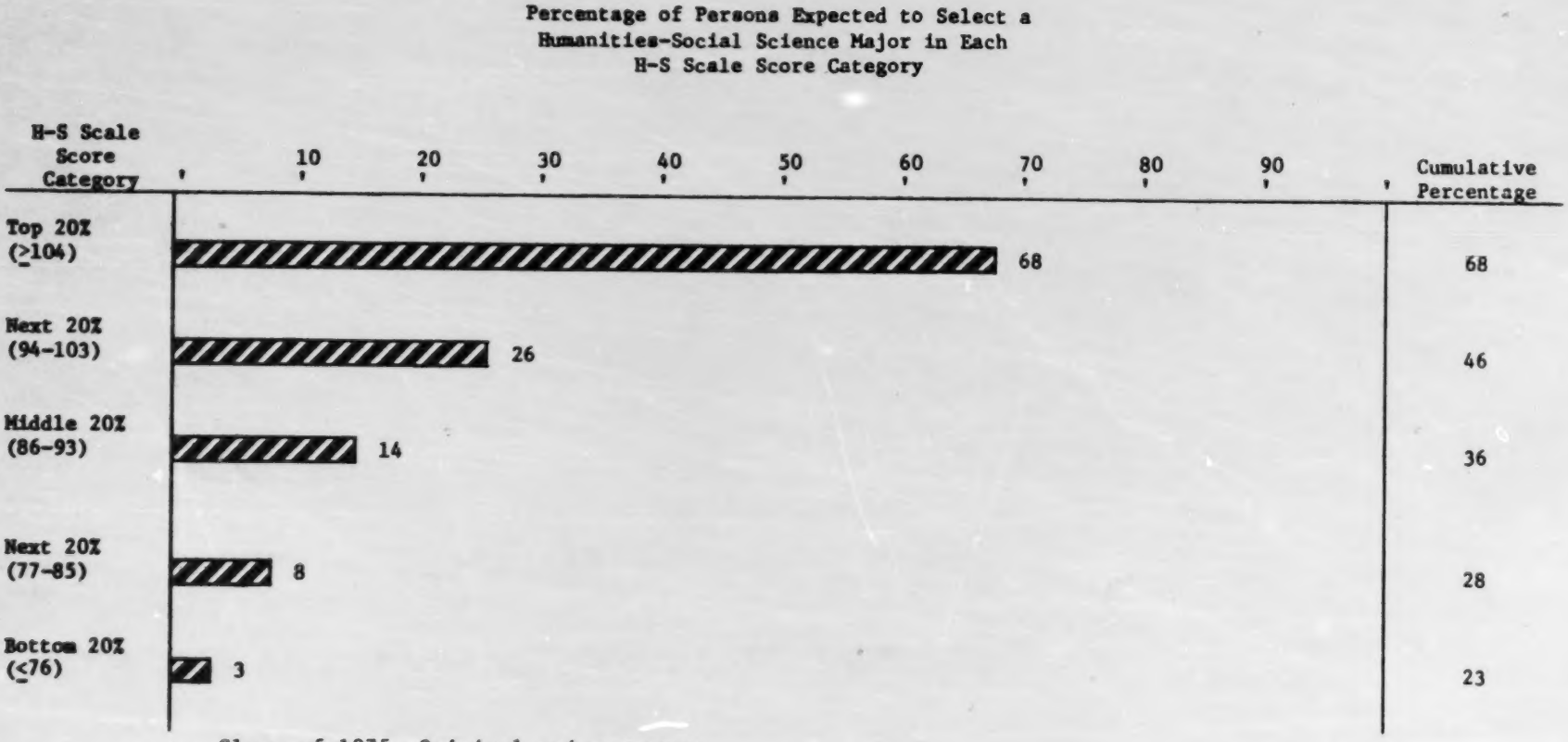
a. Class of 1971.

Figure 3. Expectancy charts showing the relationship between the H-S Scale and choice of major field for the Naval Academy classes.



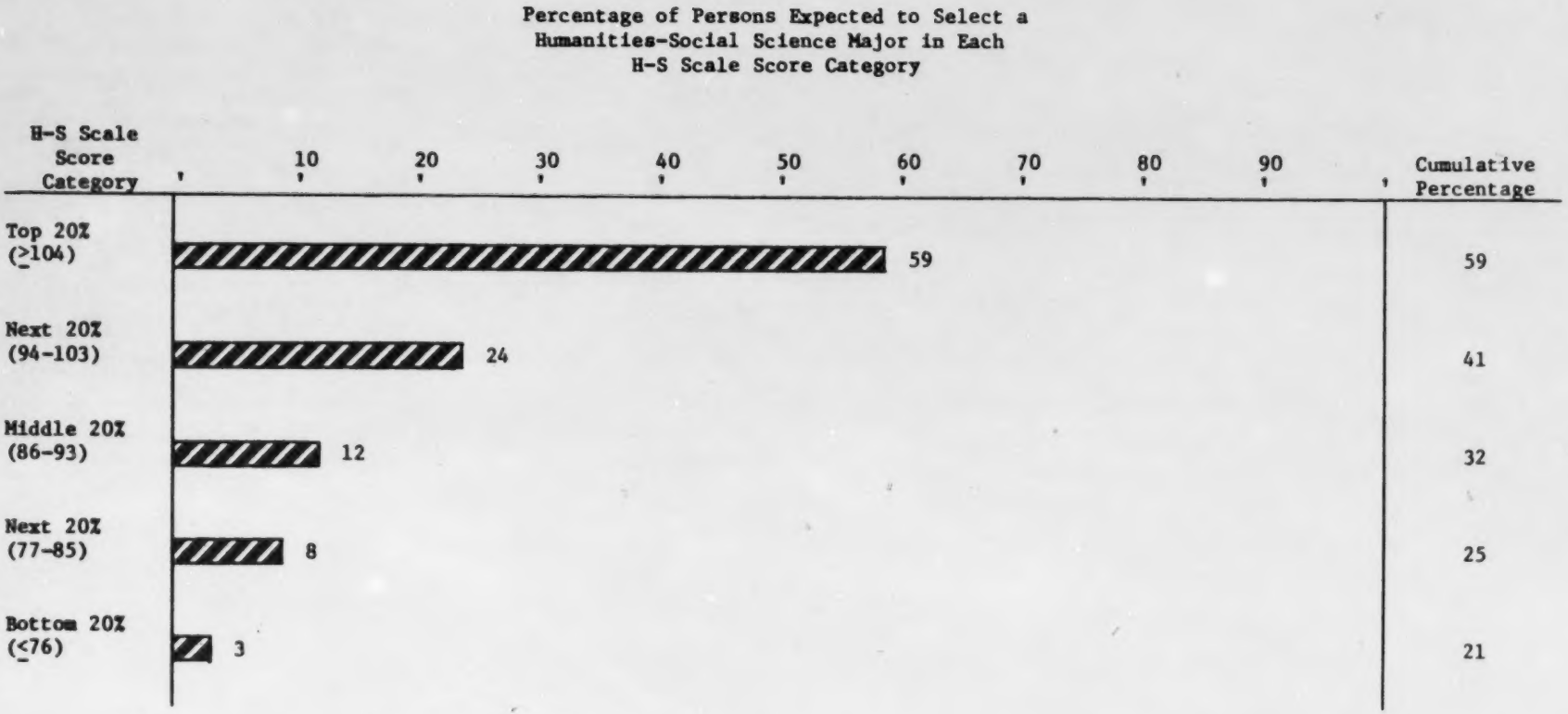
b. Class of 1972.

Figure 3. (Continued).



c. Class of 1975--Original major groups.

Figure 3. (Continued).



d. Class of 1975--Current major groups.

Figure 3. (Continued).

Table 5

Descriptive Statistics for the Applied Science (A-S) Scale
for the Naval Academy Classes

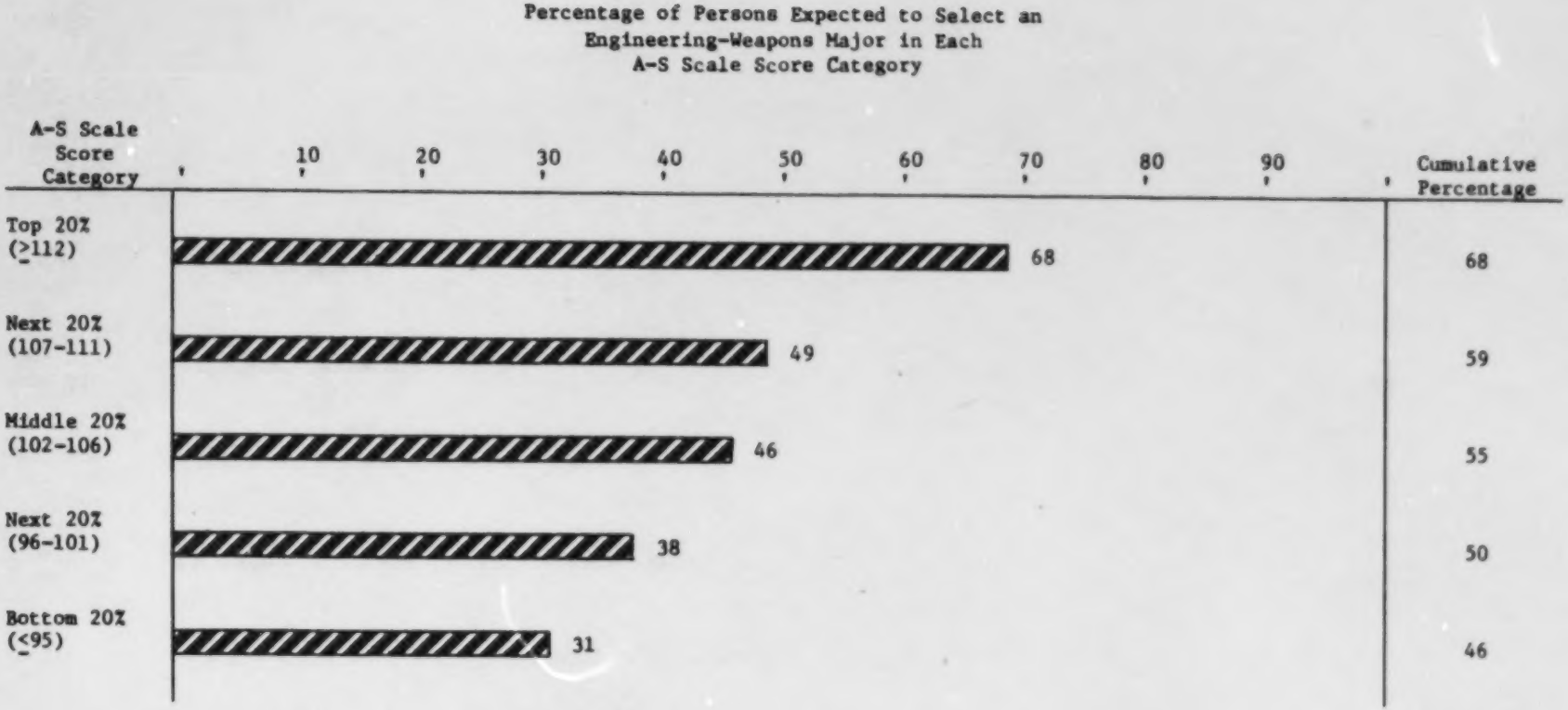
Class	Criterion Group	Major Group(s)	Sample Size	Mean	Standard Deviation	Biserial Validity	Percent Overlap
1971	High	I	225	106.036	9.229		
	Low	II	264	101.292	8.849	.32*	79
	Total		489	103.474	9.322		
1972	High	I	169	106.456	8.695		
	Low	II	307	102.371	9.501	.27*	82
	Total		476	103.821	9.419		
1973[a]	High	I	171	107.877	9.220		
	Low	II	314	99.704	9.186	.50*	66
	Total		485	102.586	9.986		
1975[b]	High	I	280	105.543	9.636		
	Low	II	255	100.945	8.801	.30*	80
	Total		535	103.351	9.320		
1975[c]	High	I	230	105.839	9.793		
	Low	II	382	100.982	8.962	.31*	80
	Total		612	102.807	9.570		

[a]The statistics for the Class of 1973 are biased, as the scale was constructed using these persons. Specifically, capitalization on chance inflates the validity and deflates the percent overlap.

[b]These results are based upon the original majors organization.

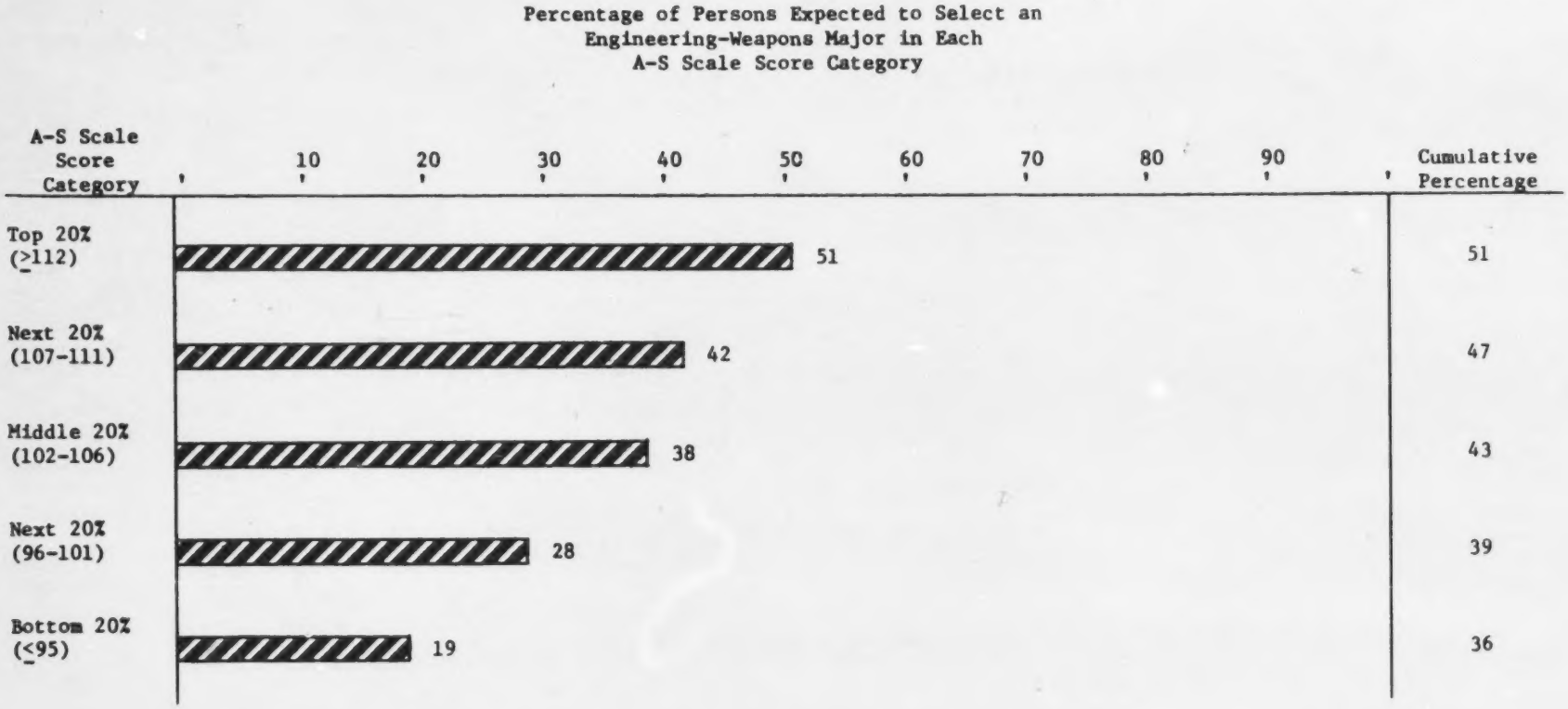
[c]These results are based upon the current majors organization.

*Statistically significant ($p < .01$), based upon Alf & Abrahams (1971).



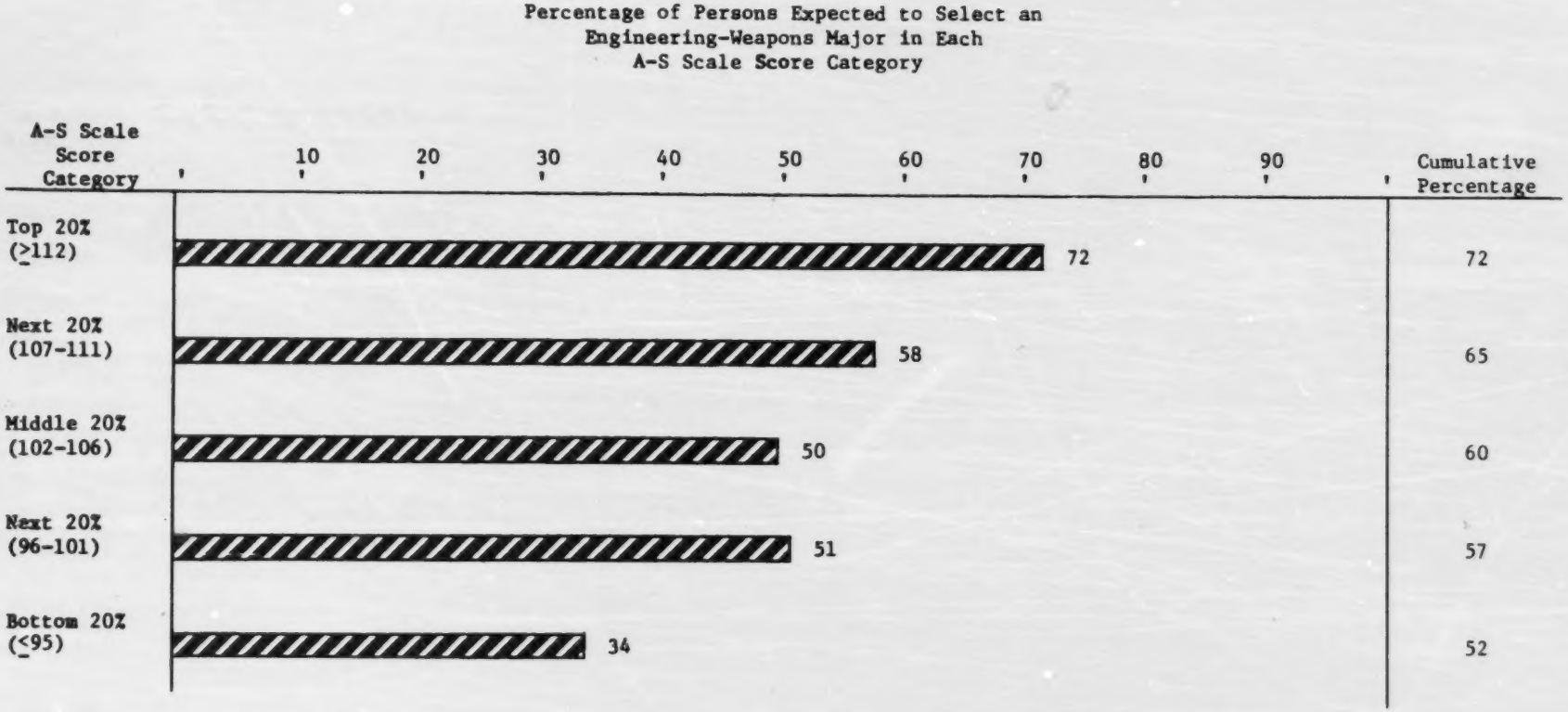
a. Class of 1971.

Figure 4. Expectancy charts showing the relationship between the A-S Scale and choice of major field for the Naval Academy classes.



b. Class of 1972.

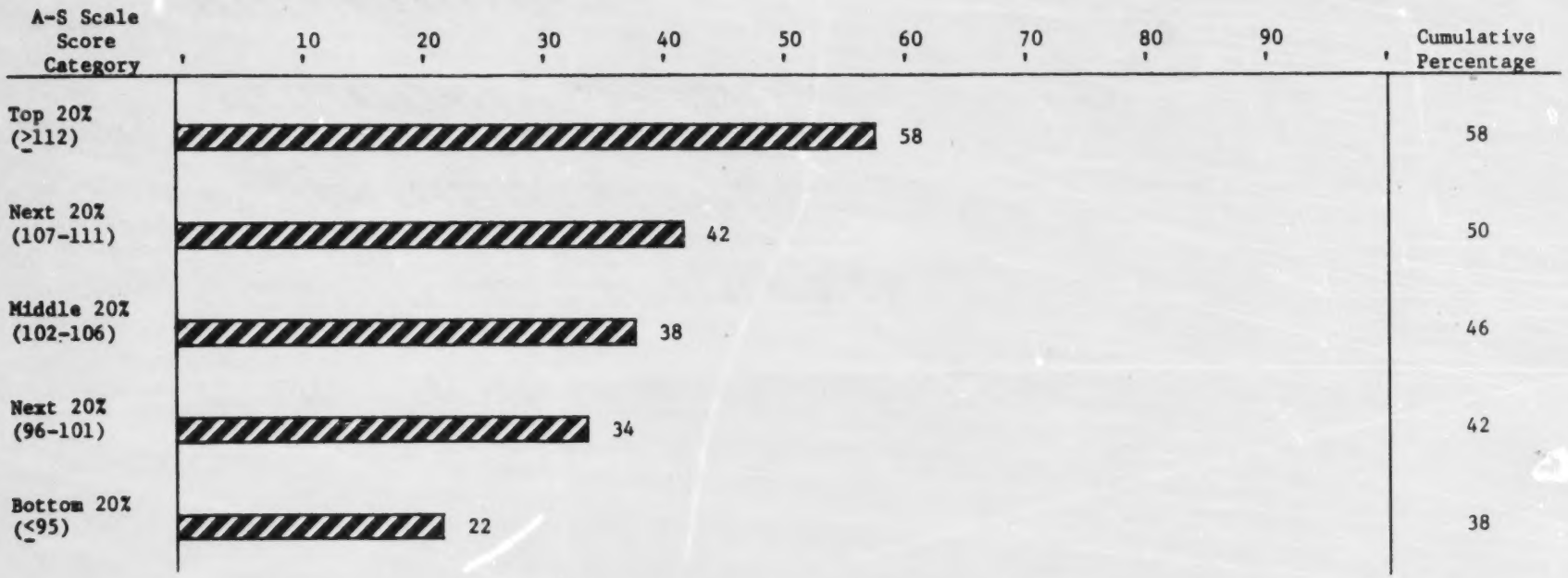
Figure 4. (Continued).



c. Class of 1975--Original major groups.

Figure 4. (Continued).

Percentage of Persons Expected to Select an
Engineering-Weapons Major in Each
A-S Scale Score Category



d. Class of 1975--Current major groups.

Figure 4. (Continued).

Table 6

Comparison of Obtained and Chance Results for Alternative Classification Strategies

Naval Academy Class	N	Obtained Results: Number Hits	Obtained Results: Hit Rate %	Chance Results: Number Hits	Chance Results: Hit Rate %	Improvement Over Chance[a]: Number Hits	Improvement Over Chance[a]: Percent Improvement
			Strategy #1				
1971	660	320	48.5	239	36.2	81	33.9
1972	646	364	56.3	267	41.4	97	36.3
1973[b]	663	388	58.5	271	40.9	117	43.2
1975[c]	699	326	46.6	233	33.3	93	39.9
1975[d]	776	426	54.9	328	42.3	98	29.9
			Strategy #2				
1971	660	330	50.0	248	37.6	82	33.1
1972	646	364	56.3	279	43.1	85	30.5
1973[b]	663	401	60.5	279	42.1	122	43.7
1975[c]	699	331	47.4	242	34.6	89	36.8
1975[d]	776	432	55.7	338	43.6	94	27.8
			Strategy #3				
1971	660	345	52.3	227	34.4	118	52.0
1972	646	365	56.5	235	36.4	130	55.3
1973[b]	663	410	61.8	241	36.3	169	70.1
1975[c]	699	367	52.5	243	34.8	124	51.0
1975[d]	776	403	51.9	291	37.5	112	38.5
			Strategy #4				
1971	660	342	51.8	230	34.8	112	48.7
1972	646	356	51.1	225	34.8	131	58.2
1973[b]	663	393	59.3	230	34.7	163	70.9
1975[c]	699	366	52.4	247	35.3	119	48.2
1975[d]	776	389	50.1	278	35.8	111	39.9

[a]Obtained results are significantly more accurate than chance results ($p < .01$).

[b]The statistics for the Class of 1973 are inflated, as the scales were constructed using these persons.

[c]These results are based upon the original majors organization.

[d]These results are based upon the current majors organization.

The third and fourth strategies employ a personnel assignment algorithm which maximizes the payoff of assignments while meeting specified quotas for the three groups. With the single exception of the Class of 1975 (as majors are currently organized), Strategy #3 is the most accurate of the four alternative strategies. This result was expected, as the quotas for the three groups were set equal to the obtained historical distribution of majors for this third strategy. In effect, this procedure assumes that the obtained distribution was the desired distribution.

In Strategy #4, the quotas were set equal to the more realistic distribution of 40, 40, and 20 percent for the three groups. As indicated in Table 6, the classification accuracy of Strategy #4 suffers a slight decrement in comparison to Strategy #3. Again, this finding was expected, as the simulated institutional policy regarding quotas constrained the solution.

DISCUSSION AND CONCLUSIONS

Individual Versus Institutional Decisions

Cronbach and Gleser (1965) classified decisions as either individual or institutional. In an individual decision, the preferred course of action varies from one person to another, is dependent upon the value system of the individual, and does not reflect institutional goals. Strategies #1 and #2 may be considered as strategies of the individual type, since the one factor they consider in making classification decisions is probability of group membership.

Institutional decisions attempt to produce a maximum payoff from a series of similar decisions. Such decisions may consider personal interests of individuals, but only insofar as these interests impact upon the institutional objectives. Strategies #3 and #4 may be considered as strategies of the institutional type, since the quotas they employ for the three major academic groups reflect institutional goals rather than the personal goals of the students.

Additional Information Requirements

The scope of this investigation was limited in terms of both predictor and criterion variables examined. The predictors evaluated were empirically-derived interest scales. Other predictor data which would be considered in a realistic tryout would certainly include information on aptitude and previous achievement.

The only criterion used in this study was group membership. Other criteria that could be considered would include grade point average in the three major areas and probability of disenrollment. These multiple criteria would have to be combined in some fashion into a composite that would represent the utility of assigning a particular person to a particular major area. This composite utility would be used in the payoff matrix to replace the probability of group membership used in this study.

As explained above, the quotas used for Group I and Group II under Strategy #4 were assumed to be equal for the purposes of this investigation. Policy-makers at the Naval Academy would have to determine separate quotas for the three academic areas to ensure that the solution yielded by the assignment algorithm would produce the desired results.

Implementation of the Findings

Assuming that all important predictors and criteria had been considered and were appropriately reflected in the payoff matrix and assuming the existence of an unequivocal institutional policy statement on quotas for the three academic areas, Strategy #4 could be implemented in various ways. On the one extreme, the assignments produced by the algorithm could be used as the sole determinant of an individual's academic major area. A more realistic alternative would be

to show each person (1) an individual vector of payoffs in the alternative areas and (2) the recommended choice, but allow the person to choose from among the three alternatives. If the distribution of persons in the academic areas was in accordance with the desired distribution, these choices could stand. If significant discrepancies occurred between the number of persons desired in each particular area and the number choosing a major in that area, Academy efforts to redistribute midshipmen could be focused on those persons evidencing the greatest discrepancy between recommended and actual choice.

In conclusion, it appears that use of the optimal personnel assignment algorithm and realistic quotas, together with a payoff matrix which realistically portrays the utility of a particular major academic area for a specific individual, could make a significant contribution to the educational-vocational guidance of midshipmen.

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APPENDIX

OBTAINED VERSUS CHANCE RESULTS FOR FOUR CLASSIFICATION STRATEGIES

Obtained and Chance Results for Four Alternative Strategies for Prediction of Major Group Membership for the Class of 1971

Obtained Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	4	197	24	225
II	2	215	47	264
III	1	69	101	171
Totals	7	481	172	660

Number Hits = 320
Hit Rate = 48.5%*

Chance Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	2	164	59	225
II	3	192	69	264
III	2	125	45	172
Totals	7	481	173	661

Number Hits = 239
Hit Rate = 36.2%

Obtained Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	24	191	10	225
II	10	236	18	264
III	1	100	70	171
Totals	35	527	98	660

Number Hits = 330
Hit Rate = 50.0%*

Chance Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	12	180	33	225
II	14	211	39	264
III	9	137	25	171
Totals	35	528	97	660

Number Hits = 248
Hit Rate = 37.6%

Obtained Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	111	95	19	225
II	86	130	48	264
III	28	39	104	171
Totals	225	264	171	660

Number Hits = 345
Hit Rate = 52.3%*

Chance Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	77	90	58	225
II	90	106	68	264
III	58	68	44	170
Totals	223	264	170	659

Number Hits = 227
Hit Rate = 34.4%

Obtained Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	125	88	12	225
II	101	130	33	264
III	38	46	87	171
Totals	264	264	132	660

Number Hits = 342
Hit Rate = 51.8%*

Chance Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	90	90	45	225
II	106	106	53	265
III	68	68	34	170
Totals	264	264	132	660

Number Hits = 230
Hit Rate = 34.8%

*Obtained hit rate is significantly greater than chance hit rate ($p < .01$).

Obtained and Chance Results for Four Alternative Strategies for Prediction of Major Group Membership for the Class of 1972

Obtained Results For Strategy #1

Actual Group	I	II	III	Totals
I	4	149	16	169
II	5	251	51	307
III	0	61	109	170
Totals	9	461	176	646

Number Hits = 364
Hit Rate = 56.3%*

Chance Results For Strategy #1

Actual Group	I	II	III	Totals
I	2	121	46	169
II	4	219	84	307
III	2	121	46	169
Totals	8	461	176	645

Number Hits = 267
Hit Rate = 41.4%

Obtained Results For Strategy #2

Actual Group	I	II	III	Totals
I	15	147	7	169
II	17	273	17	307
III	1	93	76	170
Totals	33	513	100	646

Number Hits = 364
Hit Rate = 56.3%*

Chance Results For Strategy #2

Actual Group	I	II	III	Totals
I	9	134	26	169
II	16	244	48	308
III	9	135	26	170
Totals	34	513	100	647

Number Hits = 279
Hit Rate = 43.1%

Obtained Results For Strategy #3

Actual Group	I	II	III	Totals
I	72	82	15	169
II	71	187	49	307
III	26	38	106	170
Totals	169	307	170	646

Number Hits = 365
Hit Rate = 56.5%*

Chance Results For Strategy #3

Actual Group	I	II	III	Totals
I	44	80	44	168
II	80	146	81	307
III	44	81	45	170
Totals	168	307	170	645

Number Hits = 235
Hit Rate = 36.4%

Obtained Results For Strategy #4

Actual Group	I	II	III	Totals
I	100	60	9	169
II	115	164	28	307
III	44	34	92	170
Totals	259	258	129	646

Number Hits = 356
Hit Rate = 55.1%*

Chance Results For Strategy #4

Actual Group	I	II	III	Totals
I	68	67	34	169
II	123	123	61	307
III	68	68	34	170
Totals	259	258	129	646

Number Hits = 225
Hit Rate = 34.8%

*Obtained hit rate is significantly greater than chance hit rate ($p < .01$).

Obtained and Chance Results for Four Alternative Strategies for Prediction of Major Group Membership for the Class of 1973

Obtained Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	9	144	18	171
II	5	256	53	314
III	1	54	123	178
Totals	15	454	194	663

Number Hits = 388
Hit Rate = 58.5%*

Chance Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	4	117	50	171
II	7	215	92	314
III	4	122	52	178
Totals	15	454	194	663

Number Hits = 271
Hit Rate = 40.9%

Obtained Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	28	139	4	171
II	6	276	32	314
III	2	79	97	178
Totals	36	494	133	663

Number Hits = 401
Hit Rate = 60.5%*

Chance Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	9	127	34	170
II	17	234	63	314
III	10	133	36	179
Totals	36	494	133	663

Number Hits = 279
Hit Rate = 42.1%

Obtained Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	92	68	11	171
II	65	200	49	314
III	14	46	118	178
Totals	171	314	178	663

Number Hits = 410
Hit Rate = 61.8%*

Chance Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	44	81	46	171
II	81	149	84	314
III	46	84	48	178
Totals	171	314	178	663

Number Hits = 241
Hit Rate = 36.3%

Obtained Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	122	45	4	171
II	110	173	31	314
III	33	47	98	178
Totals	265	265	133	663

Number Hits = 393
Hit Rate = 59.3%*

Chance Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	68	68	34	170
II	126	126	63	315
III	71	71	36	178
Totals	265	265	133	663

Number Hits = 230
Hit Rate = 34.7%

*Obtained hit rate is significantly greater than chance hit rate ($p<.01$).

Obtained and Chance Results for Four Alternative Strategies for Prediction of Major Group Membership for the Class of 1975-Original Major Groups

Obtained Results
For Strategy #1

Actual Groups \ Classification Group	I	II	III	Totals
I	4	253	23	280
II	1	216	38	255
III	0	58	106	164
Totals	5	527	167	699

Number Hits = 326
Hit Rate = 46.6%*

Chance Results
For Strategy #1

Actual Groups \ Classification Group	I	II	III	Totals
I	2	211	67	280
II	2	192	61	255
III	1	124	39	164
Totals	5	527	167	699

Number Hits = 233
Hit Rate = 33.3%*

Obtained Results
For Strategy #2

Actual Groups \ Classification Group	I	II	III	Totals
I	33	236	11	280
II	10	225	20	225
III	3	88	73	164
Totals	46	549	104	699

Number Hits = 331
Hit Rate = 47.4%*

Chance Results
For Strategy #2

Actual Groups \ Classification Group	I	II	III	Totals
I	18	220	42	280
II	17	200	38	255
III	11	129	24	164
Totals	46	549	104	699

Number Hits = 242
Hit Rate = 34.6%*

Obtained Results
For Strategy #3

Actual Groups \ Classification Group	I	II	III	Totals
I	147	111	22	280
II	95	119	41	255
III	38	25	101	164
Totals	280	255	164	699

Number Hits = 367
Hit Rate = 52.5%*

Chance Results
For Strategy #3

Actual Groups \ Classification Group	I	II	III	Totals
I	112	102	66	280
II	102	93	60	255
III	66	60	38	164
Totals	280	255	164	699

Number Hits = 243
Hit Rate = 34.8%*

Obtained Results
For Strategy #4

Actual Groups \ Classification Group	I	II	III	Totals
I	142	120	18	280
II	93	132	30	255
III	45	27	92	164
Totals	280	279	140	699

Number Hits = 366
Hit Rate = 52.4%*

Chance Results
For Strategy #4

Actual Groups \ Classification Group	I	II	III	Totals
I	112	112	56	280
II	102	102	51	255
III	66	65	33	164
Totals	280	279	140	699

Number Hits = 247
Hit Rate = 35.3%*

*Obtained hit rate is significantly greater than chance hit rate ($p<.01$).

Obtained and Chance Results for Four Alternative Strategies for Prediction of Major Group Membership for the Class of 1975-Current Major Groups

Obtained Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	4	208	18	230
II	1	316	65	382
III	0	58	106	164
Totals	5	582	189	776

Number Hits = 426
Hit Rate = 54.9%*

Chance Results For Strategy #1

Actual Group \ Classification Group	I	II	III	Totals
I	1	173	56	230
II	2	287	93	382
III	1	123	40	164
Totals	4	583	189	776

Number Hits = 328
Hit Rate = 42.3%

Obtained Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	30	191	9	230
II	15	329	38	382
III	3	88	73	164
Totals	48	608	120	776

Number Hits = 432
Hit Rate = 55.7%*

Chance Results For Strategy #2

Actual Group \ Classification Group	I	II	III	Totals
I	14	180	36	230
II	24	299	59	382
III	10	128	25	163
Totals	48	607	120	775

Number Hits = 338
Hit Rate = 43.6%

Obtained Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	89	125	16	230
II	108	220	54	382
III	33	37	94	164
Totals	230	382	164	776

Number Hits = 403
Hit Rates = 51.9%*

Chance Results For Strategy #3

Actual Group \ Classification Group	I	II	III	Totals
I	68	113	49	230
II	113	188	81	382
III	49	81	35	165
Totals	230	382	165	777

Number Hits = 291
Hit Rate = 37.5%

Obtained Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	116	100	14	230
II	148	183	51	382
III	47	27	90	164
Totals	311	310	155	776

Number Hits = 389
Hit Rate = 50.1%*

Chance Results For Strategy #4

Actual Group \ Classification Group	I	II	III	Totals
I	92	92	46	230
II	153	153	76	382
III	66	66	33	165
Totals	311	311	155	777

Number Hits = 278
Hit Rate = 35.8%

*Obtained hit rate is significantly greater than chance hit rate ($p<.01$).

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